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	Engineering and Design CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL	
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Engineering and Design
CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN REQUIREMENTS FOR HAZARDOUS WASTE LANDFILLS

1. Purpose. This engineer manual transmits a document which describes CQA inspection requirements for hazardous waste landfill covers and liners. The appendix of this document is a template for landfill CQA plans to assist designers in incorporating the important aspects of CQA. The document may also be used in reviewing CQA plans developed by others.

2. Applicability. This manual applies to HQUSACE elements, major subordinate commands, districts, laboratories, and field operating activities (FOA) who have responsibility for preparing or reviewing CQA plans for landfills.

3. Distribution Statement. Approved for public release, distribution is unlimited

4. References. The following references provide additional information on CQA for landfills:

4.1 Quality Assurance Representatives Guide, EP 415-1-161 Volume 5, United States Army Corps of Engineers, July 1997; and

4.2 Quality Assurance and Quality Control for Waste Containment Facilities, Technical Guidance, EPA/6001R-93/182, Environmental Protection Agency, September 1993.

5. Discussion.

The federally mandated requirements for the components of a hazardous waste landfill are described in the Code of Federal Regulations (CFR) 40 CFR 264. State and local government agencies also have criteria for landfill systems and, in some instances, these criteria may be more stringent than federal guidelines. In general, the components of landfill covers and liners consist of protective cover soil layers, drainage layers, and low permeability layers. Many landfill covers also contain some type of gas control system. Drainage layers and low permeability layers are frequently constructed of geosynthetics. The term geosynthetic refers to plastic manufactured materials such as geotextiles, geomembranes, geonets, geogrids, and geocomposites.

The responsibilities of the CQA inspector are similar regardless of the regulatory criteria under which a landfill is being designed and constructed. The CQA inspector must verify that all soil layers, geosynthetic layers, and appurtenances are constructed in accordance with the plans and specifications. USACE personnel have traditionally performed CQA inspection duties on USACE

construction projects. However, at some landfill sites, a third party CQA inspector has been hired to observe the construction of some or all of the landfill. This has been done because of the amount of documentation required and the unique CQA inspection requirements involved with the construction of geosynthetic layers in landfills.

The attached standard CQA plan can be used as a tool in defining the responsibilities of a third party CQA inspector. It can also be used if USACE inspectors will be responsible for all CQA activities. However, manpower limitations may prevent USACE inspectors from performing all of the CQA duties outlined in this standard plan. The amount of documentation required by this plan is extensive and may be reduced on a site specific basis, depending on regulatory requirements. The designer should contact the regulatory authorities to determine what CQA documentation they require.

The strict CQA requirements for landfills requires coordination between the designer and field offices to determine manpower needs and to determine how much work can be performed by USACE inspectors. Work that cannot be performed by USACE inspectors will have to be performed by a third party inspector. Funds needed to perform CQA on landfills will also be greater than for most other types of construction projects. Because of this, tinding needs for CQA should be addressed during design and coordinated with the field office.

6. Actions Required. The topics listed in this document should be considered in the preparation of a CQA plan for any landfill constructed by the USACE. It is strongly recommended that input be sought from the appropriate regulatory and in-house technical staff in the preparation of any CQA plan for a landfill. The involvement of in-house technical expertise is essential to providing a cost-effective, high quality service to the customer.

7. Format. This manual provides a template for a standard CQA plan for hazardous waste landfills. The standard CQA plan is presented in Appendix A and is divided into sections with each section covering a unique aspect of CQA for landfill construction. The standard CQA plan must be modified on a site specific basis. Sections which are not applicable should be deleted. Applicable sections should be edited to meet the site specific needs of a project. Notes to the designer are also provided within the text of the standard CQA plan to provide guidance on how to edit the document.

FOR THE COMMANDER:

RUSSELL L. FUHRMAN
Major General, USA
Chief of Staff

1 Appendix
APP A Construction Quality Assurance (CQA) Plan Requirements for Hazardous Waste Landfills

APPENDIX A
CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN REQUIREMENTS FOR HAZARDOUS WASTE LANDFILLS

CONSTRUCTION QUALITY ASSURANCE PLAN FOR LANDFILLS

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SECTION 1
GENERAL

1.1 Introduction

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NOTE: Insert and delete applicable sections of this document to meet site specific requirements. The list of specification sections referenced in this paragraph must also be edited on a site specific basis.

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The Construction Quality Assurance (CQA) Engineer shall be independent from the Contractor and the Contractor's quality control (CQC) program. The CQA Engineer shall be responsible for CQA activities associated with construction of the landfill and related features and shall verify compliance with the specification sections listed below. The CQA Engineer shall review the following specification sections in preparation for CQA activities:

Section [_____]: Grading
Section [_____]: Clay Barrier Layer
Section [_____]: Soil Drainage Layer
Section [_____]: Select Fill and Topsoil For Landfill Cover
Section [_____]: Earthwork
Section [_____]: Waste Containment Geomembrane
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Section [_____]: Access Roads
Section [_____]: Electrical
Section [_____]: Mechanical

1.2 Definitions

The definitions listed in the following paragraphs are relevant to the design, construction and CQA of a landfill.

(1) Construction Quality Assurance. CQA includes inspections, audits, and evaluations of materials and workmanship to determine and document the quality of the constructed facility. CQA is performed by a party independent from the Contractor.

(2) Contracting Officer (CO). This is the individual who represents the Government. The CO is responsible for the construction of the landfill. The CO is also responsible for compliance with the requirements of the permitting agency and approval of CQA documentation. The CO will be assisted and represented on site by one or more Contracting Officer's Representatives (CORs). For the purposes of this document, the term CO shall refer to the CO and/or the on-site COR.

(3) Construction Quality Assurance Engineer. The CQA Engineer shall be a professional engineer registered in the State of [_____] and shall have a minimum of [3] [_____] years of experience as a CQA Engineer on a minimum of 5 landfill liner or cover projects. The CQA Engineer shall be responsible for carrying out the tasks outlined in the Construction Quality Assurance Plan (CQAP). The CQA Engineer shall also be responsible for ensuring that the Contractor's approved Construction Quality Control (CQC) Plan is being followed. The CQA Engineer shall be responsible for hiring CQA personnel to assist in CQA testing, reporting, verification, and documentation. For the purposes of this document, the term CQA Engineer shall refer to the CQA Engineer and/or authorized CQA Inspection Personnel.

(4) Construction Quality Assurance Inspection Personnel. The CQA inspection personnel shall be under the supervision of the CQA Engineer and shall assist in CQA testing and inspection. These personnel shall have a minimum of [2] [_____] years experience as CQA inspectors and be [_____] [NICET certified for the areas in which they will be performing CQA inspections] [individuals with an engineering (or related field) degree from an accredited university].

(5) Construction Quality Assurance Testing Laboratory. The CQA testing laboratory shall perform CQA conformance tests required by the specifications and CQAP. The CQA testing laboratory shall be hired by the [Government] [CQA Engineer]. The laboratory shall have provided CQA testing of soils and geosynthetics used for the construction of landfills for at least five completed projects having a total minimum area of 186,000 square meters (2 million square feet). The CQA laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the CQA laboratory will be required to perform.

1.3 CQA Organization Pre-Construction Submittal Requirements

The CQA organization shall submit a CQA qualifications report listing the names of CQA personnel which will be on-site and the duties of each. The CQA qualifications report shall show

the lines of authority for the on-site CQA personnel. A resume for the CQA Engineer and each CQA inspection person shall also be included in the report. The report shall be submitted for approval a minimum of [28] [_____] days prior to the start of CQA duties. If new CQA personnel are brought on site after the start of construction, a resume shall be submitted to the CO for approval a minimum of [7] [_____] days prior to the new personnel performing CQA duties.

1.4 Responsibility and Authority

The general responsibilities of the CQA Engineer are listed below. Subsequent chapters of this document provide specific CQA requirements during the construction of various components of the landfill.

(1) Review applicable plans and specifications.

(2) Review the CQA Plan.

(3) Review approved changes to the plans and specifications.

(4) Review and recommend approval or disapproval of site-specific documentation, including contractor submittals, manufacturer's information, installer's information, and referenced standards. The CO will make the final decision on approval or disapproval of submittals.

(5) Verify construction is performed in accordance with the plans and specifications. Inspectors shall be assigned to every major construction activity being performed. A minimum of one CQA Engineer shall be on-site at all times during landfill construction.

(6) Attend required meetings.

(7) Educate CQA inspection personnel on site specific CQA requirements and procedures.

(8) Assign CQA inspection personnel to observe all activities requiring monitoring.

(9) Confirm calibrations of CQC and CQA testing equipment are correctly performed and recorded.

(10) Confirm that CQC and CQA tests are properly performed, recorded, and the results meet specified requirements.

(11) Review contractor personnel qualifications to verify conformance with the specifications.

(12) Review warranty submittals to verify they comply with the specified warranty requirements.

(13) Verify that the contractor is following the approved CQC plan.

(14) Review required submittals and recommend rejection or approval.

(15) Report any unapproved deviations from the CQAP.

(16) Note any activities that could result in damage to installed landfill components.

(17) Prepare and maintain required reports, files, and logs.

(18) Oversee the collection, marking, packaging, and shipping of CQA conformance samples.

(19) Review as-built surveys and drawings.

1.5 References

The following references were used in preparation of this document:

(1) Quality Assurance Representatives Guide, EP 415-1-161 Volume 5, United States Army Corps of Engineers, July 1997; and

(2) Quality Assurance and Quality Control for Waste Containment Facilities, Technical Guidance, EPA/600/R-93/182, United States Environmental Protection Agency, September, 1993.

1.6 Submittal Review

The CQA Engineer shall review all submittals required by the specification sections referenced in this CQAP to ensure they comply with the specified requirements. The CQA Engineer shall also review as-built surveys and drawings to ensure the drawings are prepared correctly and construction is in compliance with the plans and specifications.

1.7 Meetings

The following paragraphs summarize the meetings the CQA Engineer shall attend prior to and during construction.

1.7.1 Pre-Construction Meeting

A preconstruction meeting shall be held at the site prior to the beginning of construction. The meeting shall be attended by the CQA engineer, CQA inspection personnel, CO, general contractor, and other concerned parties. Specific topics for the preconstruction meeting shall include the plans and specifications, the CQAP, areas of confusion, safety, CQC documentation, and the responsibilities of each party.

1.7.2 Weekly Progress Meetings

Weekly progress meetings shall be held between the CQA Engineer, CQA inspection personnel, CO, general contractor, appropriate subcontractors, and other concerned parties. The purpose of these meetings is to discuss current progress, planned activities for the next week, issues requiring resolution, and any revisions to the work. The CQA Engineer shall report any deficiencies noted during the previous week.

1.7.3 Contractor Coordination Meetings

The CQA Engineer and appropriate CQA inspection personnel shall attend coordination meetings with each major subcontractor prior to the start of construction activities. Specific topics for the coordination meetings shall include the plans and specifications, the CQAP, areas of confusion, safety, and the responsibilities of each party.

1.7.4 Safety Meetings

The CQA Engineer and CQA inspection personnel shall attend required safety meetings.

1.8 CQA Samples

1.8.1 CQA Sample Collection

CQA samples shall be collected at locations designated by the CQA Engineer. The CQA Engineer shall [collect] [be present during collection of] CQA samples and ensure they are collected, cut, labeled, and packaged in accordance with the specifications and/or CQAP. The CQA Engineer shall ensure samples are labeled with the following: sample number; date sampled; project name; geosynthetic manufacturer or soil borrow source; and intended use of soil or geosynthetic. The location, sample number, and purpose of the samples shall be noted on the daily report.

1.8.2 CQA Sample Testing

The CQA Engineer shall [submit samples] [ensure samples are submitted] to the CQA laboratory

for testing. Subsequent sections of the CQAP describe the tests to be performed.

1.8.3 CQA Test Results

****
NOTE: At some projects, the CQA Engineer is required to witness all or a portion of the CQA tests being performed to ensure the tests are being run in accordance with specified requirements.
****

The CQA Engineer shall verify test results meet the requirements stated in the specifications. The following shall be verified when reviewing CQA test results:

(1) Geosynthetic samples and borrow soils used for CQA testing are identical to the materials used for full-scale construction;

(2) The correct tests were performed and specified test procedures were used; and

(3) Test results are in accordance with the specifications. The CQA Engineer shall immediately notify the CO of problems with CQA testing procedures or test results.

SECTION 2
SOILS

2.1 General

General soils CQA requirements are discussed in this section. Additional requirements for specific types of soils are discussed in subsequent sections.

2.1.1 CQA Personnel

All individuals assigned CQA responsibilities for soil layers shall have provided CQC and/or CQA inspection during installation of [clay barrier layers] [and] [protective soil layers] for at least 3 landfill projects totaling a minimum of [50,000 cubic meters (65,000 cubic yards) of clay barrier layer soil] [and] [50,000 cubic meters (65,000 cubic yards) of protective soil layer material].

2.1.2 Equipment

Visually inspect and verify soil processing, placement, and compaction equipment meet the requirements described in the specifications.

2.1.3 Weather Conditions

Verify that soil placement or compaction does not occur during periods of freezing temperatures, if it is raining excessively, or if other detrimental weather conditions exist.

2.2 Execution

****

NOTE: The frequency at which lift thickness and the number of compactor passes is measured is a function of the number and type of CQA inspectors on site. If CQA is being performed by government inspectors, typically, manpower will limit the amount of field measurements that can be made. However, if a third party CQA engineer is used, the frequency of inspection should be higher (perhaps once per hour). Other factors to consider when specifying the frequency of measurement are the importance of the soil being placed, the size of the project, and the timing of when tests are performed. Tests may be performed more frequently at the start of a project to verify the contractor's placement methods are adequate. As work progresses, the frequency of testing may be reduced if the contractor has performed well during the earlier stages of construction.

****

2.2.1 Subgrade Preparation

(1) Verify the subgrade is smooth, free of voids, and composed of satisfactory materials. Also verify the subgrade is compacted as specified.

(2) Ensure the elevation of the top surface of the subgrade is correct.

(3) Verify the subgrade surface is scarified as specified prior to placement of the first lift of soil.

2.2.2 Soil Placement

During soil placement, verify the following:

(1) Equipment is not operated at speeds exceeding specified limits;

(2) Sudden braking or sharp turns are not made;

(3) Slippage of placement and compaction equipment is not occurring on side slopes. This is especially important when the soil layer is underlain by geosynthetics. The CQA Engineer shall also verify there are no thin areas of soil which could allow underlying geosynthetics to be punctured or torn;

(4) Loose lifts are no greater than the specified maximum allowable thickness. A CQA Engineer shall physically measure the loose lift thickness of each soil layer being placed a minimum of [3] [_____] times per 8-hour shift at randomly selected locations;

(5) Soil contains no large clods or other material prohibited by the specifications. The CQA Engineer shall physically measure clods and other materials that appear to be too large in size; and

(6) Soil is placed to the lines and grades shown on the drawings by comparing the contract drawings with as-built surveys and raw data located on known control points and grade stakes.

2.2.3 Compaction

(1) Verify the specified minimum number of passes are being made over all areas of each lift of soil (if applicable). For each soil layer being placed, a CQA Engineer shall spot check the number of passes over a specific area at least [3] [_____] times per 8-hour shift.

(2) Visually observe soil placement around all penetrations and verify that soil placed around penetrations does not contain voids and is adequately compacted.

(3) Inspect pipes which penetrate soil layers for damage due to placement and compaction equipment.

(4) Verify the surface of each lift is adequately scarified prior to placement of the next lift of soil.

(5) Verify low ground pressure equipment is used when compaction is required over piping, geosynthetics, or other appurtenances.

2.2.4 Tests

2.2.4.1 Borrow Tests

(1) Check CQC borrow test results (moisture content, sieve analysis, Atterberg limits, compaction tests, hydraulic conductivity, etc.) to verify that the borrow material is uniform and matches the required properties given in the specifications.

(2) Advise the CO about the need to do additional borrow source assessment testing if the properties of a borrow source appear to have changed significantly.

2.2.4.2 In-Place Moisture Content and Density Tests

Verify the following during testing of the in-place soil layer:

(1) CQC moisture content and density tests are performed at the specified frequency;

(2) Locations of CQA tests are immediately adjacent to CQC testing locations so that test results can be compared. The sample numbers of these adjacent CQC and CQA tests shall be correlated so that test results can be easily compared. The CO shall be notified if CQA test results for moisture content or density consistently vary by more than +/-3 percent from CQC test results;

(3) Additional CQA tests are taken where density, moisture content, or hydraulic conductivity test results are not in compliance with the specifications or the soil is visibly suspect;

(4) The Contractor performs corrective action as a result of failed tests in compliance with the specifications and submits documentation describing the corrective measures taken;

(5) The Contractor uses nuclear gauges in the direct transmission mode to measure density;

(6) Rapid CQC moisture content and density tests are checked using standard methods at the

specified frequency. The CO shall be notified if rapid test results for moisture content or density consistently vary by more than +/-3 percent from standard test results; and

(7) Standard moisture and density tests are taken at the same location as the rapid tests so that results can be easily compared. Ensure that large equipment is not operated in the vicinity where sand cone tests are being performed.

2.2.5 Protection

(1) Ensure the contractor removes puddles and excess moisture from the soil surface prior to placement of additional soil.

(2) Look for areas of erosion after each rainfall.

(3) Inspect for damage due to freezing and/or desiccation.

(4) Ensure the contractor repairs damaged areas and reestablishes grades.

2.2.6 Repairs

If a soil layer does not conform to the specifications, the CQA Engineer shall assist the CO in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

2.2.7 Testing of Repaired Areas

****

NOTE: On some projects, the specifications require the frequency of CQC testing to increase in areas that have been repaired. CQA tests are normally correlated to the number of CQC tests required, therefore, the frequency of CQC and CQA tests would move up or down together.

****

After repairs have been made, ensure CQA and CQC retests are performed to check the repaired areas. In general, CQA tests shall be performed at the same frequency as the rest of the project. Additional CQA testing shall be performed in suspect areas.

SECTION 3
CLAY BARRIER LAYER

3.1 General

In addition to the CQA inspection requirements described in Section 2 of this CQAP, the CQA Engineer shall verify the following during clay layer construction.

3.2 Clay Properties

3.2.1 Construction Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis. Both ASTM D 698 and ASTM D 1557 are typically used to define compaction requirements for clay barrier layers. Acceptable compaction criteria are further refined using ASTM D 5084 to define the range of moisture contents and densities that meet hydraulic conductivity requirements.

****

The following table lists the CQA tests that shall be performed on the clay layer during construction.

Test Type	Test Method	Frequency	Comments
Particle Size Analysis	ASTM D 422	2,300 cu meters (3,000 cu yards)	Borrow soils
Atterberg Limits	ASTM D 4318	2,300 cu meters (3,000 cu yards)	Borrow soils
Compaction Note 1	ASTM D 698 ASTM D 1557	7,600 cu meters (10,000 cu yards)	Borrow soils
Moisture Content	ASTM D 2216	1 per 20 CQC tests	In-place soils
Density	ASTM D 1556	1 per 20 CQC tests	In-place soils

Undisturbed Sample Collection Note 2	ASTM D 1587	1/4,000 m^2/lift (1/acre/lift)	In-place soils
Hydraulic Conductivity	ASTM D 5084	1/4,000 m^2/lift (1/acre/lift)	In-place soils

Note 1: ASTM D 1557 does not need to be performed if ASTM D 698 test results are within the acceptable zone for moisture content and density.

Note 2: A pair of undisturbed samples shall be collected at each sampling location. One of the undisturbed samples shall be archived for potential additional testing. The sample shall be stored by the CQA Engineer vertically, in a cool location, and away from direct sunlight.

3.2.2 Borrow Source Inspection

****
NOTE: Require continuous inspection of the borrow source if it is highly variable. Inspections may not be feasible for off-site borrow sources.
****

[The CQA Engineer shall have an inspector assigned to the borrow source at all times during borrow processing and removal.] [The CQA Engineer shall inspect the borrow source daily.] The CQA Engineer shall verify the following during borrow soil excavation:

(1) Borrow source development, excavation, and final grading are in accordance with the contract documents and approved materials handling plan;

(2) Adequate time is provided for borrow soil to cure after the application of water. Perform additional CQA moisture content tests if there is a question about the uniformity of moisture content within the borrow soil being prepared;

(3) Clod sizes and particle sizes of the borrow soil are within specified limits; and

(4) Borrow soils are free of roots, debris, and other unacceptable materials.

3.3 Execution

3.3.1 Scarification

(1) Verify that all areas of the upper surface of each lift are scarified prior to placement of the next lift of clay.

(2) If geomembrane is to be placed on top of the clay layer, verify that a steel drum roller is used to obtain a smooth upper surface that is suitable for geomembrane deployment.

3.3.2 Repair of Penetrations

(1) Ensure that voids in the clay created for test samples, grade stakes, and other penetrations are repaired by placing and compacting clay backfill in the voids. Observe the repair of these voids at least 3 times per 8-hour shift.

(2) If sand cone density tests are performed, ensure the sand is removed prior to repairing the void.

3.3.3 Protection

(1) Verify water is applied to the surface of the clay layer to prevent drying.

(2) Inspect clay surfaces for desiccation cracks daily.

SECTION 4
PROTECTIVE SOIL LAYER

4.1 General

In addition to the CQA inspection requirements described in Section 2 of this CQAP, the CQA Engineer shall verify the following during construction of protective soil layers placed above geosynthetics. The CQA inspection requirements described in this section are applicable to all soil layers placed immediately on top of a geosynthetic layer.

4.2 Construction Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The following table lists the CQA tests that shall be performed on the protective soil layer during construction.

Test Type	Test Method	Frequency	Comments
Particle Size Analysis	ASTM D 422	1 per 2,300 cu meters (3,000 cu feet)	Borrow soils
Atterberg Limits	ASTM D 4318	1 per 2,300 cu meters (3,000 cu yards)	Cohesive borrow soils
Compaction	ASTM D 698	1 per 7,600 cu meters (10,000 cubic yards)	Borrow soils
Moisture Content	ASTM D 2216	1 per 20 CQC tests	In-place soils
Density	ASTM D 1556	1 per 20 CQC tests	In-place soils

4.3 Execution

Verify the following during protective soil layer placement:

(1) Oversize and angular material which could damage geosynthetics has been removed from the

protective soil;

(2) Cover soil is not dumped directly onto geosynthetics from a height greater than specified;

(3) Geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as protective soil is being spread over the geosynthetics;

(4) Wrinkles in geosynthetics are not folding over onto themselves during protective soil placement;

(5) Low ground pressure equipment is being used where specified;

(6) Placement of cover soil proceeds from a stable working area adjacent to the deployed geosynthetic materials and gradually progresses outward. For slopes, cover soil must be placed by starting at the toe and working up the slope;

(7) The Contractor may request permission to construct access routes to allow larger construction equipment to carry cover soil out onto the geosynthetic layers. Notify the CO to verify this is acceptable;

(8) Access routes are adequately built up to protect underlying geosynthetics. Access routes generally must be a minimum of 900 mm (3 feet) in thickness;

(9) Tracks and wheels of full scale construction equipment remain on the access routes at all times;

(10) Repairs are made to the access routes as needed. Inspect access routes daily to see if thinning of the cover soil is occurring;

(11) Large stockpiles of cover soil are not placed on top of in-place geosynthetic layers; and

(12) Thin areas of cover soil which could allow geosynthetics to be punctured or torn by construction equipment are repaired immediately.

SECTION 5
DRAINAGE SOIL LAYER

5.1 General

In addition to the CQA inspection requirements described in Section 2 of this CQAP, the CQA Engineer shall verify the following during drainage soil layer construction.

5.2 Construction Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis. In-place density requirements are typically not specified for drainage layer soils.

****

The following table lists the CQA tests that shall be performed on the drainage soil layer during construction.

Test Type	Test Method	Frequency	Comments
Particle Size Analysis	ASTM D 422	1 per 5,000 cu meters (6,500 cu yards)	Borrow soils
Hydraulic Conductivity	ASTM D 5084	1/4,000 sq meters /lift (1/acre/lift)	Borrow soils

5.3 Execution

Verify the following during drainage layer placement:

(1) Oversize and angular material which could damage geosynthetics has been removed prior to placement;

(2) Geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as protective soil is being spread over the geosynthetics;

(3) Excessive fines have not been generated as a result of handling and placement of the drainage layer;

(4) Wind-borne and water-borne fines do not contaminate the drainage layer after placement;

(5) Erosion controls are placed such that drainage layers are not contaminated by fines; and

(6) Watch for ponds of water on top of the drainage layer which may be an indication that an excessive amount of fines have contaminated the drainage layer.

SECTION 6
WASTE PLACEMENT

6.1 General

In addition to the CQA inspection requirements described in Section 2 of this CQAP, the CQA Engineer shall verify the following during waste placement.

6.2 Construction Quality Assurance Testing

****

NOTE: The following are examples of CQA tests sometimes performed during waste placement. This paragraph should be modified on a site-specific basis. CQA testing is frequently not performed on waste during placement.

At some projects, additional tests are required to verify excessive moisture will not be released from landfilled materials. Examples of these tests include the liquid release test (EPA 9096) and the paint filter test (EPA 9095). Test procedures are described in SW-846 - Test Methods for Evaluating Solid Waste.

****

The following table lists the CQA tests that shall be performed during waste placement.

Test Type	Test Method	Frequency	Comments
Compaction	ASTM D 698	1 per 7,600 cu meters (10,000 cu yards)	Prior to placement
Density	[ASTM D 1556] [ASTM D 2922]	1 per 20 CQC tests	In-place soils

6.3 Execution

(1) Verify stockpiles containing contaminated material are bermed, lined, and covered. Also verify a means of managing leachate is provided.

(2) Verify waste material is placed so that large void spaces do not exist.

(3) Compaction of waste is usually specified by requiring several passes of a compactor over all

areas of the waste instead of requiring that a specific density criteria be achieved. At least 3 times per 8-hour period, spot-check to make sure the contractor is making the minimum required number of passes for each lift of waste placed.

(4) For landfill liner systems, verify the contractor's method of placement does not damage the liner.

(5) Immediately notify the CO if unexpected hazardous materials (barrels, tanks, medical waste, UXO, etc.) are discovered during waste regrading or placement.

(6) Verify the contractor minimizes the amount of waste exposed during regrading operations to reduce odor problems.

(7) Notify the CO if odor or volatilization of contaminants becomes a problem. Daily cover may need to be placed over areas of exposed waste.

(8) When waste is being regraded, look for leachate seeps that present unsuitable conditions for fill placement. Report such seeps to the CO.

(9) For landfill liner systems, verify the contractor implements measures to remove runoff which collects in the landfill.

(10) Check for areas where additional fill needs to be placed due to settlement.

(11) For landfill liner systems, check interim surveys to verify adequate space is available within the landfill to store all contaminated material.

(12) Verify final lines and grades of the regraded and in-place waste are correct.

SECTION 7
VEGETATIVE COVER LAYER

7.1 General

In addition to the CQA inspection requirements described in Section 2 of this CQAP, the CQA Engineer shall verify the following during construction of the vegetative cover layer.

7.2 Construction Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The following table lists the CQA tests that shall be performed on the vegetative cover soil layer during construction. No CQA tests shall be performed on silt fences or erosion control blankets. However, these materials shall be visually inspected to ensure the correct types of materials have been delivered and are free of damage.

Test Type	Test Method	Frequency	Comments
Particle Size Analysis	ASTM D 422	1 per 2,300 cu meters (3,000 cu yards)	Borrow soils
pH	ASTM D 4972	1 per 2,300 cu meters (3,000 cu yards)	Borrow soils

7.3 Execution

7.3.1 Vegetative Cover Layer

The CQA Engineer shall verify the following:

(1) Vegetative soil layer is uniformly distributed over the designated areas to the specified depth; and

(2) Vegetative soil layer is placed by starting at the toe and working up the slope.

7.3.2 Vegetation

The CQA Engineer shall verify the following:

(1) Seed and fertilizer are stored in a cool, dry location away from contaminants;

(2) Pesticides, insecticides, herbicides, and other materials are delivered in their original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses;

(3) Vegetative operations are performed only during periods when weather conditions are acceptable;

(4) Drainage patterns are maintained as indicated on the construction drawings;

(5) New soil surfaces are blended to meet existing soil surfaces;

(6) Prior to seeding, areas which have been damaged by rain, traffic, or other causes are reworked to restore the specified ground condition;

(7) Seeds and mulch are uniformly distributed. Verify seed and mulch are certified to contain no weed seed and meet specified requirements; and

(8) Immediately following spreading, mulch is mechanically anchored by forcing it into the soil surface using a v-wheel compactor or other appropriate equipment.

7.3.3 Erosion Control Blanket

The CQA Engineer shall verify the following if erosion control blankets are used:

(1) The area to be covered is properly prepared, fertilized, and seeded before the erosion control blanket is applied;

(2) Biodegradable erosion control blankets are stored in dry conditions and are protected from sunlight until placed;

(3) Areas which are to receive an erosion control blanket are smooth;

(4) Wire staples are vertically applied through the blanket so that the blanket is kept taut. Also, verify that staples are not so long that they damage underlying geosynthetics;

(5) Water cannot flow underneath the edges of the blankets;

(6) Overlaps are the correct width and are shingled in the direction of flow; and

(7) Placement of erosion control material does not damage the subgrade or disturb seeded areas.

7.3.4 Erosion Control Fence and Hay Bales

The CQA Engineer shall verify the following:

(1) Soil erosion control fences, berms, and other structures are installed at the locations indicated on the construction drawings;

(2) The bottoms of silt fences are properly buried in a trench and the trench is backfilled as specified; and

(3) Hay bales are tied firmly with wire or plastic ties, secured by wood stakes, and are partially buried.

7.3.5 Maintenance

The CQA Engineer shall inspect vegetation and erosion control material weekly and after each large storm event to verify the following:

(1) Silt fences and erosion control blankets are adequately maintained;

(2) Eroded areas are repaired;

(3) Reseeding is performed as required;

(4) Excessive amounts of silt are removed from behind silt fences and hay bales; and

(5) Areas are protected from traffic through the use of appropriate barricades and signs.

SECTION 8
GEOSYNTHETICS

8.1 General

General geosynthetic CQA requirements are discussed in this section. Additional requirements for specific types of geosynthetics are discussed in subsequent sections.

8.1.1 CQA Personnel

All individuals assigned CQA responsibilities for geosynthetics shall have provided CQC and/or CQA inspection during installation of geosynthetics for at least 3 projects totaling a minimum of 93,000 square meters (1 million square feet) of geosynthetics.

8.1.2 Equipment

Verify equipment used to place and cover geosynthetics is in accordance with the specifications and the manufacturer's recommendations.

8.1.3 Delivery, Storage, and Handling

The CQA Engineer shall fill out a receiving inspection report (see Chapter 17) for each delivery of geosynthetics. In addition, the CQA Engineer shall be present during delivery and unloading and shall verify the following:

(1) Geosynthetics are shipped, handled, and stored in such a manner that no damage occurs to the geosynthetics;

(2) GCLs, geotextiles, geonets, and geocomposites are packaged in opaque, waterproof, protective coverings;

(3) Each roll of geosynthetics is labeled in accordance with the specifications; and

(4) Rolls of geosynthetics which are damaged beyond use are removed from the site.

8.1.4 Weather Conditions

(1) Verify weather conditions are acceptable for placement of geosynthetics.

(2) Ensure the subgrade has not been damaged by inclement weather.

(3) Ensure winds are not so high as to cause damage to geosynthetics during deployment. Inspect any geosynthetic rolls or panels which have been displaced by wind.

8.2 Geosynthetic Material Properties

8.2.1 Quality Control Testing

The CQA Engineer shall review manufacturing quality control test results to verify that geosynthetic rolls are sampled and tested in accordance with the manufacturer's approved quality control manual and that test results not meeting the requirements specified result in the rejection of applicable rolls.

8.2.2 Quality Assurance Testing

(1) The CQA Engineer shall ensure CQA samples are collected at the rate specified in the following sections and forwarded to the CQA Laboratory for testing.

(2) Unless otherwise specified or approved, verify CQA samples are not taken from the outer wrap of the roll and samples are a minimum of 1 meter (3 feet) in length by the roll width.

8.3 Execution

8.3.1 Subgrade

The subgrade surface shall be inspected and approved each day that geosynthetics are installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the subgrade after approval. The CQA Engineer shall verify the following during subgrade inspections:

(1) The subgrade is compacted in accordance with the specifications; and

(2) The subgrade is smooth and free of ruts, erosion rills, or protrusions which are greater than specified.

8.3.2 Deployment

The CQA Engineer shall verify the following during deployment:

(1) Geosynthetics are laid reasonably flat with a minimum of wrinkles so that they contain no areas that can fold over during covering;

(2) Geosynthetics are placed with the correct side facing up;

(3) There are no broken needles present in the geosynthetics;

(4) The installer cuts out and repairs waves that are so large as to cause folding of the geosynthetics when they are covered;

(5) There are no tensile stresses in the deployed geosynthetics;

(6) Geosynthetics are not damaged during deployment;

(7) The Contractor has adequate ballasts (e.g., sandbags) on hand and they are properly deployed to prevent uplift of the geosynthetics by wind;

(8) Construction personnel are not smoking or wearing shoes that could damage the geosynthetics;

(9) Seams are lapped in the correct direction; and

(10) Verify geotextiles, geocomposite drainage layers, and GCLs are not dragged across the surface of a textured geomembrane. This can result in damage to the geocomposite. A sacrificial rub sheet may be used to alleviate this problem.

8.3.3 Damage

The CQA Engineer shall visually inspect geosynthetics for damage (e.g., holes, blisters, and creases) after placement. Damaged areas shall be marked. The CQA Engineer shall document the location of the damaged panels, repairs which were performed, and panels which were rejected.

8.3.4 Field Seams, Overlaps, and Splices

The CQA Engineer shall visually inspect seams and overlaps and verify the following:

(1) Seams are oriented parallel to the line of maximum slope;

(2) Geosynthetics are positioned with the overlap width as specified;

(3) Overlaps that occur on slopes are constructed with the up slope roll shingled over the down slope roll; and

(4) Protective cover soil is not inadvertently pushed into seam overlaps.

8.3.5 Penetrations

(1) Verify penetrations are located as shown on the plans.

(2) Verify penetrations are constructed and tested as recommended by the manufacturer and as specified.

8.3.6 Anchor Trenches

Verify the following when inspecting anchor trenches:

(1) The anchor trench is constructed to the correct dimensions;

(2) Termination points of geosynthetic layers within the anchor trench are correct;

(3) Corners of the anchor trench are slightly rounded to avoid sharp bends in the geosynthetics;

(4) Loose soil or objectionable materials such as geosynthetic scraps and food containers are removed from the bottom of the anchor trench prior to placement of geosynthetics;

(5) The anchor trench is dewatered (pumped out) if standing water is present in the bottom of the trench;

(6) The anchor trench is backfilled with approved soil placed at the specified moisture content and density; and

(7) Compaction work within the anchor trench does not damage the geosynthetics.

8.3.7 Final Inspection

The CQA Engineer shall visually inspect and verify that all deficiencies are repaired in accordance with the specifications prior to covering.

SECTION 9
GEOMEMBRANE

9.1 General

In addition to the CQA inspection requirements described in Section 8 of this CQAP, the CQA Engineer shall verify the following during geomembrane layer construction.

9.2 Geomembrane

9.2.1 Resin Certifications

Prior to installation of geomembrane, the CQA Engineer shall review quality control certificates issued by the resin supplier. The CQA Engineer shall compare resin source lot numbers from the manufacturer with the manufacturer's roll listing to verify the proposed resin was used to manufacture the rolls delivered to the site.

9.2.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The following table lists the CQA tests that shall be performed on the geomembrane during construction.

Test Type	Test Method	Frequency	Comments
Thickness	ASTM D 5199 (Smooth) ASTM D 5994 (Textured)	1 per 9,300 sq meters (1 per 100,000 sq ft)	Field measurement
Elongation at Break	ASTM D 638	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement
Tensile Strength at Break	ASTM D 638	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement

Tear Resistance	ASTM D 1004	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement

9.3 Execution

9.3.1 Subgrade Preparation

Each day during placement of geomembrane, the CQA Engineer and geomembrane installer shall inspect the surface on which geomembrane is to be placed and prepare a Certificate of Subgrade Acceptance (see Section 17).

9.3.2 Geomembrane Deployment

9.3.2.1 Field Panel Placement

The CQA Engineer shall visually inspect and verify that field panels are installed at the locations and positions indicated on the contractor's approved layout drawings. The CQA Engineer shall record the identification code, location, and date of installation of each field panel.

9.3.2.2 Deployed Geomembrane

The CQA Engineer shall visually inspect the deployed geomembrane to verify the following:

(1) Wrinkles do not exceed specified requirements;

(2) The geomembrane installer provides sufficient slack in the deployed geomembrane to account for the temperature fluctuations anticipated; and

(3) After a significant drop in temperature, the geomembrane has not pulled away from the subgrade or anchor trench.

9.3.2.3 Thickness Measurement

(1) The CQA Engineer shall perform and record (see Section 17) field thickness measurements to verify geomembranes meet specified requirements.

(2) The CQA engineer shall report thickness measurements which fall below the specified minimum requirements to the CO.

9.3.3 Field Seams

9.3.3.1 Seam Layout

(1) The CQA Engineer shall verify the proposed seam layout is in accordance with the specified requirements.

(2) The CQA Engineer shall verify that field seams are laid out as shown on the approved panel layout drawing.

9.3.3.2 Seams

The CQA Engineer shall verify that:

(1) Trial seams are made under field conditions;

(2) Seaming equipment is in good condition and is functioning properly;

(3) Seams are of high quality. Pay special attention to high stress points such as valleys, ridges and at penetrations;

(4) Trial seam log information is included in the CQA daily report;

(5) Seam areas are clean and free of moisture, dust, dirt, and foreign material;

(6) If grinding of the surfaces to be seamed is required, the grinding marks are oriented perpendicular to the seam direction and no marks extend beyond the extrudate after placement;

(7) The depth of the grinding marks are no greater than 10 percent of the sheet thickness; and

(8) Where extrusion welds are terminated long enough to cool, they are ground prior to applying new extrudate over the existing seams.

9.3.3.3 Nondestructive Seam Quality Control Continuity Testing

(1) The CQA Engineer shall verify all seams are nondestructively tested as seaming work progresses and seams which fail are repaired.

(2) The CQA Engineer shall document the outcome (see Chapter 17) of all nondestructive seam test results.

9.3.3.4 Destructive Seam Testing

The CQA Engineer shall:

(1) Select locations where seam samples will be cut out for CQA and CQC strength testing. The Contractor shall not be informed in advance of the locations where the seam samples will be taken;

(2) Ensure seam strength testing is done as the seaming work progresses, not at the completion of field seaming;

(3) Verify seams are labeled in accordance with the specifications;

(4) Document CQA seam test results and repairs (see Section 17); and

(5) Verify seams which fail CQA and/or CQC destructive seam testing are repaired in accordance with the geomembrane specification.

9.3.4 Appurtenances

The CQA Engineer shall verify that:

(1) Installation and connection of the geomembrane to appurtenances has been done in accordance with the drawings and specifications;

(2) The geomembrane has not been damaged while being connected to appurtenances; and

(3) Each pipe boot is properly constructed and attached to the penetration. Verify the boots have not pulled away from the penetration if they are subjected to cyclic warming and cooling.

SECTION 10
GEOSYNTHETIC CLAY LINER (GCL)

10.1 General

In addition to the CQA inspection requirements described in Section 8 of this CQAP, the CQA Engineer shall verify the following during GCL layer construction.

10.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The following table lists the CQA tests that shall be performed on the GCL during construction.

Test Type	Test Method	Frequency	Comments
Bentonite Mass/Unit Area	ASTM D 5993	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement
Flux	ASTM D 5887	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement
Peel Strength	ASTM D 4632	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement

10.3 Execution

10.3.1 Subgrade Preparation

Each day during placement of GCL, the CQA Engineer and GCL installer shall inspect the surface on which GCL is to be placed and prepare a Certificate of Subgrade Acceptance (see Section 17).

10.3.2 GCL Deployment

The CQA Engineer shall verify that GCL which has been hydrated prior to being covered is removed and replaced. Hydrated GCL is defined as material, which has become soft as determined by squeezing the material with finger pressure or material that has exhibited swelling.

10.3.3 Field Seams and Overlaps

The CQA Engineer shall visually inspect seams and overlaps and verify the following:

(1) Granular bentonite is placed along the entire overlap width at the rate recommended by the GCL manufacturer; and

(2) Adhesives or other approved seaming methods recommended by the manufacturer are used if horizontal seams are allowed on slopes.

10.3.4 Protection

The CQA Engineer shall visually inspect and verify that only those GCL panels which can be anchored and covered before the end of the day are removed from the packaging. If exposed GCL cannot be covered before the end of the day, verify it is covered with a plastic cover material and ballasted until construction can resume.

SECTION 11
GEOTEXTILE

11.1 General

In addition to the CQA inspection requirements described in Section 8 of this CQAP, the CQA Engineer shall verify the following during geotextile layer construction.

11.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The CQA Engineer shall verify the CQA test results are in compliance with the requirements of the specifications.

Test Type	Test Method	Frequency	Comments
Grab Tensile	ASTM D 4632	1 per 9,300 sq meters (1 per 100,000 sq ft)	All geotextiles
Apparent Opening Size	ASTM D 4751	1 per 9,300 sq meters (1 per 100,000 sq ft)	Filter geotextiles and geocomposites only
Permittivity	ASTM D 4491	1 per 9,300 sq meters (1 per 100,000 sq ft)	Filter geotextiles and geocomposites only
Mass	ASTM D 5261	1 per 9,300 sq meters (1 per 100,000 sq ft)	Cushion geotextiles only
Puncture	ASTM D 4833	1 per 9,300 sq meters (1 per 100,000 sq ft)	Cushion geotextiles only
Trapezoidal Tear	ASTM D 4533	1 per 9,300 sq meters (1 per 100,000 sq ft)	Cushion geotextiles only

Note: All CQA geotextile tests shall be performed at the CQA laboratory.

11.3 Execution

(1) Verify sewn, heat bonded, and overlapped seams are constructed in the specified locations.

(2) Verify sewn seams are constructed using the correct overlap, thread type, and stitch type.

(3) Inspect for skipped stitches in stitch bonded seams.

(4) Inspect for discontinuities in heat bonded seams.

(5) Ensure the geotextile is not being burned through during the fabrication of heat bonded seams.

(6) Inspect geotextile for damage if it has been placed on a textured geomembrane surface and then removed from the membrane.

(7) Check the specifications to determine the maximum allowable exposure time for the deployed geotextile. If the allowable exposure time has been exceeded, determine if the geotextile has been damaged. If needed, request the performance of additional CQA tests to verify the physical properties of the textile have not diminished due to exposure.

(8) Ensure that staples or pins are not used to hold geotextiles in place if the geotextile will be placed immediately above other geosynthetics.

(9) Inspect the geotextile for evidence of clogging from eroded or wind blown soil.

SECTION 12
GEONET AND GEOCOMPOSITE

12.1 General

In addition to the CQA inspection requirements described in Section 8 of this CQAP, the CQA Engineer shall verify the following during geonet/geocomposite layer construction.

12.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The CQA Engineer shall verify the following CQA test results are in compliance with the requirements of the specifications.

Test Type	Test Method	Frequency	Comments
Transmissivity	ASTM D 4716	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement
Tensile Strength	ASTM D 5035	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement
Peel Strength	ASTM D 413	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement for geocomposites only

12.3 Execution

(1) During deployment, verify ribs of the geonet are continuous and are securely attached to each other.

(2) Verify seams are constructed as specified. Also verify seams are not placed in locations prohibited by the specifications.

(3) Verify plastic fasteners are used to join adjacent rolls and they are placed at the specified spacing.

(4) Verify fasteners are of contrasting color with the geonet to facilitate visual inspection.

(5) Ensure the geocomposite is not being damaged during the fabrication of heat bonded geotextile seams.

(6) Inspect geonet/geocomposite for evidence of clogging from eroded or wind blown soil.

SECTION 13
GEOGRID

13.1 General

In addition to the CQA inspection requirements described in Section 8 of this CQAP, the CQA Engineer shall verify the following during geogrid layer construction.

13.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The CQA Engineer shall verify the following CQA test results are in compliance with the requirements of the specifications.

Test Type	Test Method	Frequency	Comments
Wide Width Tensile Strength	ASTM D 4595	1 per 9,300 sq meters (1 per 100,000 sq ft)	Laboratory measurement. CQA tests shall be performed in the machine direction and cross-machine direction

13.3 Execution

(1) Inspect all in-place geogrid, geogrid anchors, and geogrid connections prior to covering.

(2) Notify the CO if the contractor proposes to splice rolls of geogrid together on slopes.

(3) For penetrations through the geogrid, ensure load carrying members of the geogrid are not cut and are spread around the penetration.

CHAPTER 14
PLASTIC PIPE

14.1 General

CQA requirements for plastic pipe, valves, manholes and other items associated with piping are discussed in this section.

14.1.1 Equipment

Verify equipment used to place and cover pipe is in accordance with the specifications and the manufacturer's recommendations.

14.1.2 Delivery, Storage, and Handling

The CQA Engineer shall be present during delivery and unloading and shall verify the following:

(1) Pipe and appurtenances are not damaged during shipping, storage, and handling;

(2) Deliveries are properly recorded;

(3) The correct material type, strength, and pipe sizes have been delivered;

(4) The size, number and location of pipe perforations are as specified;

(5) Pipes with gouges deeper than 10 percent of the wall thickness are rejected or repaired before use; and

(6) Out-of-round pipe which cannot be properly joined together is rejected.

14.1.3 Weather Conditions

Verify weather conditions are acceptable for pipe placement.

14.2 Material Properties

14.2.1 Quality Control Testing

The CQA Engineer shall verify that pipe is sampled and tested in accordance with the approved manufacture's quality control manual and test results not meeting the requirements specified

results in the rejection of applicable pipe.

14.2.2 Quality Assurance Testing

****

NOTE: CQA testing is generally not performed on plastic pipe. EPA/600/R-93/182 - Quality Assurance and Quality Control for Waste Containment Facilities provides guidance on CQA tests that can be performed on plastic pipe.

****

The CQA Engineer shall visually inspect all pipe, valves, joints, and other pipe appurtenances to ensure they are in compliance with the specifications. No formal CQA conformance testing for pipe shall be performed unless deemed necessary by the CO. The CQA Engineer shall advise the CO on the need for CQA testing.

Test Type	Test Method	Frequency	Comments
Standard Pipe Dimensions	ASTM D 2122	Spot check each shipment of pipe	Field measurement

14.3 Execution

14.3.1 Pipe

Verify the following during pipe placement:

(1) Pipe is carried to the place of installation and not dragged;

(2) Defective or damaged pipe is not used;

(3) Pipe is not laid when trench conditions or weather is unsuitable;

(4) Pipe is not installed if standing water is present;

(5) Pipe and accessories are carefully lowered into the trench;

(6) Pipe is placed at the lines and grades indicated in the plans and specifications. Verify the contractor does not lay pipe on blocks to produce the specified grade;

(7) Specified bedding is used and the bedding is graded to provide a cradle for proper support of

the pipe;

(8) The full length of each section of pipe rests solidly upon the pipe bedding layer with recesses excavated to accommodate couplings and joints;

(9) Compaction requirements are being met for bedding layers located around the pipe;

(10) Perforated pipe is installed with the perforations facing down unless otherwise specified;

(11) Pipe and fittings are free of dirt, oil, or other contaminants;

(12) The interior of pipe and accessories are thoroughly cleaned of foreign matter before being lowered into the trench;

(13) Pinch bars and tongs for aligning or turning pipe are used only on the bare ends of pipe;

(14) Bell and spigot connections are seated properly with no foreign material introduced into the connection;

(15) If piping is glued, the glue is allowed to set within the recommended temperature range and there is adequate ventilation since the glue may be both hazardous and/or flammable;

(16) All required leak tests are performed successfully prior to backfilling. The CQA Engineer shall be present for all leak tests;

(17) When work is not in progress, open ends of pipes, fittings, and valves are securely plugged or capped so that no trench water, earth or other substance enters the pipe and fittings; and

(18) The entire length of pipe is cleaned out prior to operating pumps.

14.3.2 Dual Containment Pipe

The following are additional requirements for dual containment pipe:

(1) If an electrical leak detection system is used, verify ends of the containment pipe are sealed overnight and when work is not ongoing. Dirt or water which enters the annular space will interfere with the leak detection cable and could cause operational problems;

(2) Verify dual containment pipe is sloping as shown on the drawings so that fluid flows in the containment pipe to a sump or tank; and

(3) Verify the containment pipe provides complete containment of the carrier pipe, carrier pipe elbows, fittings, and joints.

14.3.3 Valves

(1) Verify the specified types of valves are installed (e.g., ball, gate, butterfly, etc.).

(2) Verify open/close indicators are clearly marked on the valve housing.

(3) Inspect valves for leaks and correct operation and verify valves are hydrostatically tested.

(4) Verify valves are replaced if leaks cannot be repaired.

SECTION 15
RIPRAP AND OTHER RUNOFF CONTROL FEATURES

15.1 General

CQA requirements for riprap and other runoff control features are discussed in this section.

15.1.1 Delivery, Storage, and Handling

The CQA Engineer shall be present during delivery and unloading and shall verify the following:

(1) Individual pieces of stone protection are free from cracks, seams, and other defects that will cause rapid deterioration during service;

(2) Riprap and bedding material visually appear to be reasonably well-graded and falls within the limits of the riprap specification;

(3) Riprap consists of stones which are approximately rectangular in cross section and free from thin slabby pieces, dirt clods, mud and other deleterious materials; and

(4) No rock is furnished from any source which has not been sampled, tested, and approved for use.

15.2 Material Properties

15.2.1 Quality Control Testing

The CQA Engineer shall review certified test results from the quarry to verify that riprap meets specified requirements.

15.2.2 Quality Assurance Testing

****

NOTE: The following are examples of CQA tests typically performed. This paragraph should be modified on a site-specific basis.

****

The CQA Engineer shall visually inspect and measure riprap delivered to the site. No formal CQA conformance testing for riprap shall be performed unless deemed necessary by the CO. The CQA Engineer shall advise the CO on the need for CQA testing. If CQA testing is performed, the

CQA Engineer shall verify representative samples are used for this testing.

15.3 Execution

By visual inspection, the CQA Engineer shall verify placement of bedding material and stone protection are in compliance with the following paragraphs.

15.3.1 Bedding Material

Verify the following during placement of bedding and intermediate course material:

(1) Bedding material is spread uniformly on the prepared subgrade;

(2) Any damage to the subgrade during placement of bedding material is repaired before proceeding with work;

(3) Bedding material is finished to present a reasonably even surface free from depressions, mound, or windrows; and

(4) Particle size separation does not occur during placement.

15.3.2 Riprap Placement

Verify the following during riprap placement:

(1) Stone protection is placed in a manner to produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids;

(2) Damage to bedding material does not occur;

(3) The entire mass of stone in their final position is roughly graded to conform to the gradation specified; and

(4) Dumping stone at the top of slopes and rolling or pushing into place does not occur.

15.4 Gabions

Verify the following during gabion construction:

(1) All adjoining empty gabion units are connected by wire lacing along the perimeter of their

contact surfaces;

(2) Lacing is accomplished as described in the specifications;

(3) Welded wire fabric structures are not damaged and there is a minimum of voids between the stones during filling operations;

(4) The last layer of stone is level with the top of the gabion to allow for proper closing of the lid and to provide an even surface that is uniform in appearance;

(5) Lids are stretched tight over the stone fill until the lid meets the perimeter edges of the front and end panels. The lid should be tightly laced with tie wire along all edges, ends, and internal cell diaphragms by continuous stitching;

(6) All projections or wire ends are turned into the baskets; and

(7) Where a complete gabion unit cannot be installed, the basket is cleanly cut, folded, and wired together to suit existing site conditions.

15.5 Grout Bags

(1) Ensure grout bags are not pulling out of the anchor trench as the bags are filled with grout.

(2) Ensure grout bags are fully expanded with grout.

15.6 Benches and Channels

(1) Visually inspect for dips and reverse grades along bench and channel bottoms.

(2) For channels at the toe of a landfill cover, verify the outlet pipes for the cover drainage layer are not obstructed or damaged during construction of the toe channel.

SECTION 16
APPURTENANCES

16.1 General

CQA requirements for landfill appurtenances are discussed in this section.

16.2 Sumps

(1) Sumps are very labor intensive and difficult to construct. Continuous visual inspection during construction activities shall be performed in sump areas by the CQA Engineer.

(2) Carefully inspect placement of sump stone to ensure underlying geosynthetics are not being damaged.

(3) Ensure pipe perforations meet specified requirements and are placed at the correct locations.

(4) Verify pumps and other mechanical equipment are in accordance with the specifications.

(5) Verify that test operation of pumps, level alarms, valves, switches, and controls have been performed in accordance with manufacturer's recommendations and all equipment is operational.

16.3 Access Ramp

(1) Verify construction contractors comply with requirements concerning vehicle speeds and number of vehicles on the access ramp.

(2) Verify that construction equipment is not braking sharply while on the ramp.

(3) Inspect the access ramp daily for cracks and slippage of the protective soil layer. Also verify the protective soil layer is not thinning due to traffic or erosion.

16.4 Gas Collection System

16.4.1 Gas Collection Wells and Monitoring Probes

(1) Verify that drill cuttings are disposed of as required by the specifications.

(2) Check that wells are set straight and true to line and are constructed using specified materials and procedures.

(3) Verify that the completed wells are visibly marked and protected to prevent damage during future construction of the cover system.

(4) Verify that a boring log and an as-built installation diagram are submitted for each well.

16.4.2 Collection Trenches

(1) Verify that collection trenches are constructed at the proper depth and alignment.

(2) Verify that any collection pipes in the trenches are placed at the proper lines and grades.

(3) If geosynthetics are included in trenches, ensure that subgrade/sidewall protrusions or backfill placement does not damage the geosynthetics.

16.4.3 Piping and Conveyance Systems

(1) Verify that conveyance pipe and connections are installed in accordance with the requirements outlined in Section 14.

(2) Ensure that the proper burial depths and pipe slopes are maintained.

(3) Verify that the pipes slope towards condensate collection tanks and do not have any dips or low spots where condensate can collect and clog the pipe.

(4) Verify that the specified valves, gages, gas monitoring ports, and flexible couplings are installed at each well head.

SECTION 17
CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

17.1 GENERAL

****

NOTE: The amount of documentation required by this plan is extensive and may be reduced on a site specific basis. The designer should contact the regulatory authorities to determine what CQA documentation they will require. The data sheets shown at the end of this section are representative of the types of data sheets filled out during a landfill cover or liner construction project. Responsibility for filling out the attached data sheets varies from project to project. On some projects, many of these data sheets are filled out as part of the CQC documentation process. In this case, the CQA Engineer will typically spot check the data sheets to be sure they are being filled out correctly and accurately. On other projects, the CQA Engineer is responsible for documenting almost all aspects of a landfill construction project. In this case, all the attached data sheets will be filled out by CQA inspectors and engineers.

****

The CQA Engineer shall document all construction inspection and testing activities with logs, reports, and photographs. The data sheets to be used for CQA documentation shall be as presented at the end of this section. With the approval of the CO, data sheets presented in this CQA Plan may be revised as necessary by the CQA Engineer. Additional data sheets needed to record test results and observations shall be submitted to the CO for approval.

17.2 CQA Engineer's Daily Report

The CQA Engineer's Daily Report shall be prepared by the CQA Engineer and submitted weekly to the CO. At a minimum, the Daily Report shall include the following information:

(1) Date, project name, location, and other identifying information;

(2) Weather conditions;

(3) A narrative describing construction activities underway;

(4) CQA activities performed;

(5) Summary of CQA and CQC tests performed and test methods used;

(6) Summary of CQA and CQC test results, including corrective actions taken for all

construction materials not in compliance with project specifications;

(7) A list of items requiring the CO's attention;

(8) Summary of geosynthetic materials placed including locations, panel numbers, seams completed, test results, repairs, and methods of repairs;

(9) Documentation of borrow sources used and placement activities for all soils. Note any visual changes in borrow soils;

(10) Corrective actions taken to repair damage;

(11) Visual observations noted on all construction activities, including any concerns noted;

(12) Summary of results for CQA lift thickness, density, and moisture content measurements; and

(13) Record of significant discussions or conferences with the CO, subcontractors, CQC personnel, and others.

17.3 Receiving Inspection Report

Receiving inspection reports shall be completed for incoming geosynthetics and other materials. An example receiving report is provided for the delivery of geosynthetics.

17.4 Certificate of Subgrade Acceptance

A certificate of subgrade acceptance shall be signed each day geomembrane or GCL materials are placed. Each certificate shall be signed by the installer and CQA Engineer prior to installation of the geomembrane or GCL. The area being accepted must be described on the certificate.

17.5 Geomembrane Panel Deployment Log

This data sheet shall be used to record geomembrane panel numbers as they are placed in the field and to cross-reference assigned panel numbers with roll numbers. The weather conditions, time, and temperature at placement shall be recorded on the log. Measured dimensions of the geomembrane shall also be recorded on the log.

17.6 Geomembrane Trial Seam Data Sheet

Test results for each trial seam shall be recorded on the Geomembrane Trial Seam Data Sheet.

17.7 Geomembrane Seam Log

Each seam constructed shall be recorded on a geomembrane seam log.

17.8 Geomembrane Defects and Repairs

Each geomembrane defect and repair shall be recorded on a geomembrane repair log.

17.9 Non-Destructive and Destructive Geomembrane Seam Testing Data Sheets

These data sheets shall be used to record test results for all nondestructive and destructive geomembrane seam tests.

17.10 Field Moisture and Density Test Result Data Sheet

All CQA moisture content and density tests shall be recorded on this data sheet.

17.11 Test Report

This data sheet shall be used to record all other CQA test results for which a specific data sheet does not exist.

17.12 Survey Records

Record drawings resulting from the topographic surveys performed by the registered land surveyor shall be reviewed by the CQA Engineer. Record drawings shall be included as part of the Final CQA Report issued by the CQA Engineer.

17.13 Photographic Documentation

Photographic documentation shall serve as a record of work progress, problems, and repairs. Weekly photographs, consisting of at least 24 exposures, shall be taken of every phase of construction being performed. Additional photographs shall be taken to document potential contractual or regulatory problems. The basic file shall contain color prints. Negatives shall also be stored in chronological order. These photographs shall be available for review by the CO, the CQA Engineer, and other interested parties. Selected photographs shall be reproduced as part of the final report. The remaining photographs shall be transmitted to the CO for archive as part of the permanent records.

17.14 Final Report

At the completion of work, the CQA Engineer shall be responsible for writing a final report on CQA activities performed at the site. The draft final report shall be completed and submitted to the CO no more than 28 days after completion of construction and shall include, at a minimum, the following information:

(1) Brief description of the project including type of facility, name of site, location, altitude, name of owner, design engineer, general contractor, and all major subcontractors;

(2) Detailed description of the cover and lining systems, including surface area, cross sections, and a summary of all materials used;

(3) Chronological summary of construction activities;

(4) Photographic documentation, including photographs of the site at different phases of construction, photographs of construction details, and photographs of all CQA operations;

(5) General record of activities, such as dates of performance of CQA operations, number and names of CQA inspectors, and number and names of geosynthetic installer's personnel;

(6) Geosynthetic manufacturer's certification sheets and MQC documentation;

(7) Sampling and testing locations;

(8) Copies of all CQA data sheets and records completed during construction of the landfill;

(9) All CQA field and laboratory test results as well as a summary of these results;

(10) Discussion of special problems encountered and their solutions;

(11) Discussion of significant changes from design and material specifications;

(12) As-built survey records;

(13) CQA record drawings which include the geomembrane panel's layout and all survey conformance data; and

(14) A summary statement sealed and signed by the CQA Engineer documenting that CQA was conducted in accordance with the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, the landfill and related features shown on the construction

drawings were constructed in accordance with project construction drawings and specifications except as properly authorized and documented in the CQA Final Report.

QUALITY ASSURANCE REPORT (QAR) DAILY LOG OF CONSTRUCTION - MILITARY (ER 1180-1-6)	THE OCR WILL BE ATTACHED TO OR FILED WITH THE QAR.
	REPORT NUMBER
	DATE
PROJECT	CONTRACT NUMBER
CONTRACTOR (Or hired labor)	WEATHER
CQC Control phases attended and instruction given:	
Results of QA activities and tests, deficiencies observed, actions taken and corrective action of contractor. Include comment pertaining to contractors CQC activities.	
VERBAL INSTRUCTION GIVEN TO CONTRACTOR: (Include names, reactions and remarks)	
HAS ANYTHING DEVELOPED ON THE WORK WHICH MIGHT LEAD TO A CHANGE ORDER OR FINDING OF FACT? ____NO ____YES	

ENG Form 2538-1-R, May 94 (MILITARY)

Information on progress of work, causes for delays and extent of delays, weather, plant, material, etc.
Information, instructions or actions taken not covered on QCR report or disagreements:
SAFETY: (Include any infractions of approved safety plan, safety manual or instructions from Government personnel. Specify corrective action taken.)
REMARKS: (Include visitors to project and miscellaneous remarks pertinent to work.)

QA REPRESENTATIVE'S SIGNATURE	DATE	SUPERVISOR'S INITIALS	DATE

(REVERSE OF ENG FORM 2538-1-R)

RECEIVING INSPECTION REPORT
GEOSYNTHETICS

Project Name_____ **Date**_____
CQA Engineer_____

Arrival Date_____ **Unloading Method**_____
Invoice No._____ **Condition Before**
Delivery Vehicle_____ **Unloading**_____

Geosynthetic Type_____ **Number of Rolls**_____
Manufacturer's Name_____ **Storage Location**_____
Product Designation_____

Roll Number	Batch/ Lot No.	Material Dimensions			QA Samples Taken Y/N	QC Certs Recd Y/N	Damage/ Remarks*
		Length	Width	Thickness/ Weight			

* Note any damage found before or after unloading. Include any remedial steps taken or rolls rejected.

CERTIFICATE OF SUBGRADE ACCEPTANCE

Project Name_____ Date_____
Installation Contractor_____ CQA Engineer_____

Material being installed Geomembrane_____
GCL_____
Other_____

The following areas are approved for placement_____

The installer shall be responsible for maintaining the approved areas in accordance with the project specifications from this date to the completion of installation.

INSTALLER'S REPRESENTATIVE

Name	Signature	Date

CQA ENGINEER

Name	Signature	Date

CONTRACTING OFFICER

Name	Signature	Date

NOTES_____

GEOMEMBRANE PANEL DEPLOYMENT LOG

Project Name____________________________ **Date**____________________________
Installation Contractor____________________ **CQA Engineer**________________________
Geomembrane Type______________________ **Placement Equipment**__________________

Panel No.	Roll No.	Deployed		Time	Amb. Air Temp	Over-lap	Thickness Measurements						
		Length	Width				Side	No. 1	No. 2	No. 3	No. 4	No. 5	Avg
							Lead						
Sketch							Lfside						
							Rtside						
							Trail						
							Notes						

Panel No.	Roll No.	Deployed		Time	Amb. Air Temp	Over-lap	Thickness Measurements						
		Length	Width				Side	No. 1	No. 2	No. 3	No. 4	No. 5	Avg
							Lead						
Sketch							Lfside						
							Rtside						
							Trail						
							Notes						

Panel No.	Roll No.	Deployed		Time	Amb. Air Temp	Over-lap	Thickness Measurements						
		Length	Width				Side	No. 1	No. 2	No. 3	No. 4	No. 5	Avg
							Lead						
Sketch							Lfside						
							Rtside						
							Trail						
							Notes						

GEOMEMBRANE TRIAL SEAM SHEET

Project Name__________________________
Installation Contractor__________________________
Geomembrane Type__________________________

Seam Type____________________
Welding Machine Number____________________
Ambient Air Temp____________________
CQA Engineer____________________
Date/Time____________________
Sample Number____________________
Welding Technician____________________
Machine Speed____________________
Wedge Temperature____________________
Extruder Temperature____________________

Test Number	Inside Peel		Outside Peel		Shear	
	Strength	Failure Mode	Strength	Failure Mode	Strength	Failure Mode
1						
2						
3						
4						
5						
Avg						
P/F						

Seam Type____________________
Welding Machine Number____________________
Ambient Air Temp____________________
CQA Engineer____________________
Date/Time____________________
Sample Number____________________
Welding Technician____________________
Machine Speed____________________
Wedge Temperature____________________
Extruder Temperature____________________

Test Number	Inside Peel		Outside Peel		Shear	
	Strength	Failure Mode	Strength	Failure Mode	Strength	Failure Mode
1						
2						
3						
4						
5						
Avg						
P/F						

Seam Type____________________
Welding Machine Number____________________
Ambient Air Temp____________________
CQA Engineer____________________
Date/Time____________________
Sample Number____________________
Welding Technician____________________
Machine Speed____________________
Wedge Temperature____________________
Extruder Temperature____________________

Test Number	Inside Peel		Outside Peel		Shear	
	Strength	Failure Mode	Strength	Failure Mode	Strength	Failure Mode
1						
2						
3						
4						
5						
Avg						
P/F						

GEOMEMBRANE SEAM LOG

Project Name_____ Prepared By_____ Date_____
Installation Contractor_____ Reviewed By_____ Date_____
Geomembrane Type_____

Machine Number_____
Destructive Length Carry-Over from Previous Log_____

Passing Trial Seams

Number	Time	Tech ID

Note 1: Reference seam end points from an end of seam (EOS), a repair number, or a point location on the seam.
Note 2: Non-destructive test columns are to be used by the data reviewer only.

Seam Number	Seam Section (Note 1) Start Point	Seam Section (Note 1) Finish Point	Start Time	Amb. Air Temp	Weld Tech	Mach Speed	Machine Temperatures: Digital Set Wedge or Barrel Nozzle	Machine Temperatures: Indicator Wedge or Barrel Nozzle	Weld Length	Length From Last Dest. Test	Dest. Test No.	CQA Insp	Remarks	Non-Destruct Tests: Test Date	Non-Destruct Tests: CQA Insp
								Daily Total							
										Destructive Length Carry-Over					

GEOMEMBRANE REPAIR LOG

Project Name_____ Prepared By_____Date_____
Installer_____ Reviewed By_____Date_____
Geomembrane Type_____

Machine Number_____

Passing Trial Seams		
Number	Time	Weld Tech

Defect					Repair						
Defect Number	Defect Type	Location	Date	CQA Engr	Time/ Date	Repair Type	Approx Dimension	Weld Tech	Test Date	CQA Engr	Remarks

Defect Code:
AD - Animal Related Damage
B - Undispersed Resin Bead
BO - Fusion Welder Burn
BS - Boot/Skirt for FML
CO - Change of Overlap
CR - Crease
D - Installation Damage
DS# - Destructive Test Number
EE - Earthwork Equipment Damage
EXT - Extension
FM - Fishmouth
FS - Failed Seam Length
FTS - Field Test Strip
HT - Heat Tack Burn
IO - Insufficient Overlap
MD - Manufacturer/Delivery Damage
PT - Pressure Test Cut
SI - Soil Surface Irregularity
SL - Slag on Textured Sheet
T - Three Panel Intersection
VL - Vacuum Test Leak
WR - Wrinkle
WS - Welder Restart
O - Other

Repair Type:
P - Patch
GW - Grind Weld
RS - Reconstructed Seam
C - Cap

NON-DESTRUCTIVE GEOMEMBRANE SEAM TESTING DATA SHEET

Project Name_____
Material Description_____
Geomembrane Type_____

Date_____
CQA Engineer_____

Date/ Time	Seam No.	Seam Length	Air Pressure Testing						Vacuum Box	Notes
			Pressure			Time				
			Start	End	+/-	Start	End	P/F	P/F	

DESTRUCTIVE GEOMEMBRANE SEAM TESTING DATA SHEET

Project Name_____
Material Description_____
Geomembrane Type_____

Date_____
CQA Engineer_____

Test Type CQA or CQC	Date/ Time	Samp. No.	Seam No.	Mach No.	Shear (S) or Peel (P)	Shear/Peel Values Test Number					Pass/ Fail	Date to Lab	Lab Pass/ Fail	Remarks
						1	2	3	4	5				

DESTRUCTIVE SEAM TEST LOG

Project Name_____
Material Description_____
Geomembrane Type_____

Date_____
CQA Engineer_____

Sample Number	Seam Number	Machine Number	Quality Control		Quality Assurance			Remarks
			Date of Test Results	Test Result Pass/Fail	Date Shipped	Test Result Pass/Fail	Date of Notification	

FIELD MOISTURE AND DENSITY TEST RESULT DATA SHEET

Project Name_____ Date_____

Soil Type_____ CQA Engineer_____

Test No.	Date	Test Type Standard/ Nuclear	North/ South Coord	East/ West Coord	Lift No.	Dry Dens	Mois. Cont. (%)	Max. Dry Dens	Opt. Mois. Cont. (%)	Compaction (%)	Mois. Cont. (+/- of opt).	Pass/ Fail	Remarks

TEST REPORT

Project Name_____ **Date**_____
Material Type
Tested_____ **CQA Engineer**_____

Location/Sheet Number	Test Performed	Reason for Test	Test Results	Pass/ Fail	CQA Engr	Date	Remarks